(19) Japan Patent Office (JP)
(12) KOKAI TOKKYO KOHO (A)
(11) Laid-open Application Number: 7-47878
(43) Publication Date: February 21, 1995

(51) Int. Cl.[6]		Id. No.	F1	Techn. Ind. Field.
B60Q 1/08		8715-3K		
B60Q 1/14	F	8715-3K		
F21M 3/05	B	8409-3K		
F21M 3/18		8409-3K		
H04N 7/18	K			

Examination Request: None No. of Claims: 2 OL (total pages 8)

(21) Application No. 5-194464
(22) Application Filed: August 5, 1993

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Continued on the last page

(54) [Title of the Invention] HEADLAMP FOR VEHICLE

(57) [Abstract]

[Object] To reduce the light curtain phenomenon of headlamps in bad weather.

[Structure] The position of the other vehicle present in front of the vehicle is recognized with a TV camera 22 and an image processing unit 48, and the cut line of headlamps 18, 20 is moved within the prescribed movement range by shade drive units 40, 41 according to the position of the other vehicle. If poor weather conditions such as the rain, mist, and the like, occur around the vehicle and a signal is input in a control unit, for example, if a wiper switch 68 or a fog lamp switch 70 is turned on, then the top dead center which is the uppermost position of the cut line movement range is changed to the position without the light curtain phenomenon and the cut line

is moved according to the position of the other vehicle within the movement range after the change has been made.

[Patent Claims]

[Claim 1] A headlamp for a vehicle comprising vehicle position detection means for detecting the position of the other vehicle, position changing means for changing the position of the cut line which is a boundary between an illumination region and a non-illumination region of the headlamp within the prescribed movement range, state detection means for detecting the state around the vehicle, and control means for controlling said position changing means based on the signals from said vehicle position detection means, wherein said position changing means changes the top dead center which is the uppermost position of the movement range of the cut line according to the signal from said state detection means.

[Claim 2] The headlamp for a vehicle, as described in claim 1, wherein said position changing means changes the top dead center of said cut line to the height of an almost horizontal plane of the lamp if said state detection means detects a meteorological state such as the rain, fog, and the like, in which the light curtain phenomenon of the headlamp occurs.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to a headlamp for a vehicle, more specifically, to a headlamp for a vehicle which suppresses the light curtain phenomenon occurring in front of the vehicle during driving in bad weather.

[0002] Headlamps are installed on the left and right end at the front end side of the vehicles. The lights are turned on when the road in front of the vehicle is difficult to see, e.g., in the nighttime, in order to improve forward visibility for the driver. The headlamp usually has a structure allowing the lamp to be switched between two modes: a high beam mode in which the illumination range of the beam light is mainly far from the vehicle and a low beam mode in which the region close to the vehicle is illuminated. When other vehicles such as preceding or oncoming vehicles are present, a low beam mode is most often selected so as to avoid glare that blinds the drivers of other vehicles.

[0003] In a low beam mode of the headlamp, part of the beam light (beam light illuminating the remote region) is shielded. For example, in the projector-type headlamps, a light shielding plate (referred hereinbelow as a shade) for shielding part of the beam light is provided inside the headlamp. As a result, a boundary (this boundary will be referred to hereinbelow as a cut line) is formed between the region illuminated with the beam light in front of the vehicle and the region which is not illuminated, and the beam light emitted by the light source is divided into illuminating light and non-illuminating light.

[0004] However, the problem was that, for example, when the distance to the preceding vehicle

was large, it was difficult to illuminate the appropriate range in front of the vehicle all the time. Thus, in a low beam mode the driver continuously saw a dark zone, which was the non-illuminated region of the headlamp, whereas in the high beam mode, the driver of the preceding vehicle was blinded.

[0005] A variety of methods have been suggested to resolve this problem by ensuring the visibility (maximum possible illumination range) exceeding the visibility obtained in the low beam mode (close-distance illumination range) according to the conditions around the vehicle, an example of such conventional technology being disclosed in Japanese Patent Application Laid-open No. H1-278848 titled Illumination Apparatus for Vehicles. With the apparatus disclosed in this application, the position of the other vehicle is detected with a detection sensor arranged in the vicinity of a headlamp provided with a shade, the headlamp is moved in the vertical direction according to the detection signal, the cut line position is changed, and the visibility is improved by illuminating the maximum possible illumination range, while preventing blinding of the driver of the other vehicle.

[0006] Furthermore, a head light quantity control apparatus for vehicles disclosed in Japanese Patent Application Laid-open No. S63-129641 is an example of technology improving visibility in front of the vehicle in the rain. This apparatus comprises a vehicle sensor such as a rain drop sensor for detecting rain drops or a light sensor for detecting the presence of an oncoming vehicle and decreases or increases the quantity of light emitted by the headlamp by controlling the voltage with a light quantity setting device according to the signals of sensors.

[0007] With such a structure, the rain drop sensor detects the rain, sends the respective signal to the light quantity setting device and the light quantity setting device changes the control voltage so as to increase the quantity of light emitted by the headlamp over that emitted during nice weather. As a result, the visibility in front of the vehicle can be improved.

[0008]

[Problems Addressed by the Invention] However, when the vehicle is driven in the nighttime or in bad weather (for example, in the rain or mist), the beam light is reflected and scattered greater than during normal driving. As a result, the road may not be illuminated sufficiently and the visibility in front of the vehicle may be degraded. For example, when a headlamp is in a high beam mode in the rain, the beam light projected above the horizontal surface of the lamp is reflected and scattered, causing a light curtain phenomenon creating an impression that a white wall is present in front of the vehicle.

[0009] Within the framework of the conventional technology (Japanese Patent Application Laid-open No. H1-278848), when the front illumination was conducted by moving the cut line according to the position of another vehicle, if the cut line was raised above the horizontal plane of the lamp in order to illuminate the maximum possible range, without taking the adverse weather conditions into consideration, the light curtain phenomenon occurred in front of the vehicle and the visibility was degraded. Further, with the other conventional method (Japanese

Patent Application Laid-open No. S63-129641), there was a risk of the light curtain phenomenon similarly occurring if the quantity of light above the horizontal plane of the lamp was increased in the rain, without forming the cut line in the lamp.

[0010] Accordingly, it is an object of the present invention to reduce the light curtain phenomenon and to improve the visibility in front of the vehicle by changing the top dead center of the cut light moving range during poor weather and suppressing the quantity of light above the height of an almost horizontal plane of the lamp.

[0011]

[Means to Resolve the Problems] In order to resolve the above-described problems, the present invention provides a headlamp for a vehicle comprising vehicle position detection means for detecting the position of the other vehicle, position changing means for changing the position of the cut line which is a boundary between an illumination region and a non-illumination region of the headlamp within the prescribed movement range, state detection means for detecting the state around the vehicle, and control means for controlling the position changing means based on the signals from the vehicle position detection means, wherein the position changing means changes the top dead center which is the uppermost position of the movement range of the cut line according to the signal from the state detection means.

[0012] Further the above-mentioned position changing means changes the top dead center of the cut line to the height of an almost horizontal plane of the lamp if the state detection means detects a meteorological state such as the rain, fog, and the like, in which the light curtain phenomenon of the headlamp occurs.

[0013]

[Operation] With the headlamp for a vehicle in accordance with the present invention, the position of the other vehicle in front of the vehicle is recognized with the vehicle position detection means. The control means changes the position of the cut line based on the position signal of the other vehicle with the position changing means. At this time, if the state detection means detects the meteorological state around the vehicle, under which the light curtain phenomenon of the headlamp can occur, for example, the state of the rain or mist, the control means changes the top dead center of the cut line movement range of the position changing means to the height of an almost horizontal plane of the lamp and moves the cut line according to the position of the other vehicle within the movement range after the change has been made.

[0014]

[Embodiment] An embodiment of the present invention will be explained hereinbelow with reference to FIGS. 1 through 4. In the present embodiment, projector-type lamps were used as headlamps.

[0015] A front illumination lamp of the present embodiment, as shown in FIG. 4, comprises a TV

camera 22 and an image processing unit 48 as vehicle position detection means, a wiper switch 68 and a fog lamp switch 70 as state detection means, headlamps 18, 20, shade drive units 40, 41 comprising a shade forming a cut line as position changing means, and a control unit 50 as control means.

[0016] As shown in FIG. 1, a pair of headlamps 18, 20 are installed on both ends on the front edge portion in the lateral direction of a vehicle 10 on the front body 12 of the vehicle. A room mirror 16 is provided in the vicinity of the upper part of a window shield glass 14 located inside the vehicle 10. A TV camera 22 for taking the pictures representing the state in front of the vehicle is disposed close to the room mirror 16; the TV camera 22 is connected to an image processing unit 48.

[0017] Headlamps will be described below. Because the left and right lamps have the same structure, only the left headlamp 18 will be described. The headlamp 18 is a projector-type headlamp. As shown in FIG. 2 and FIG. 3, it is composed of a convex lens 30, a bulb 32, a lamp house 34, and a shade drive unit 40 comprising a shade 40A for cut line control. The lamp house 34 is secured in an almost horizontal position to a frame (not shown in the figures) of the vehicle. The convex lens 30 is secured to one opening of the lamp house 34, and the bulb 32 is secured via a socket 36 to the other opening so that the light emission point is positioned on the optical axis L (central axis of convex lens 30) of convex lens 30.

[0018] A reflector 38 with an elliptical reflective surface is formed on the valve 32 side inside the lamp house 34, and the beam light emitted by the bulb 32 is reflected by the reflector 38 and focused in the focal point on the optical axis L between the convex lens 30 and bulb 32. The shade drive unit 40 is installed in the vicinity of this focal point.

[0019] The shade drive unit 40 comprises the shade 40A rotatably supported on a rotary shaft 44 secured so as to be along the lateral direction of the vehicle inside the lamp house 34. A gear 40B is fixedly mounted on the shade 40A. A gear 40C fixedly mounted on the drive shaft of a motor 40D is engaged with the gear 40B. The motor 40D is connected to a driver 64 of a control unit 50, as shown in FIG. 4. Further, the shade 40A, as shown in FIG. 5, has a structure comprising a cam-shaped cross section 45 in which the distance from the rotary shaft 44 to the periphery changes continuously in the tangential direction, wherein the side surface has an almost cylindrical shape and changes continuously along the lateral direction of the vehicle. The cut line of the headlamp is formed by a horizontal portion 46 and an inclined portion 47 formed on the side surface of shade 40A.

[0020] The beam light of bulb 32 that has been reflected and focused by the reflector 38 is partially shielded by the shade 40A, and the remaining portion of the beam light is illuminated from the convex lens 30. The motor 40D is rotated by being driven according to the signals from the control unit 50. The position of the cut line of the beam line changes in the vertical direction according to the rotation of the shade 40A.

[0021] FIG. 6 and FIG. 7 illustrate schematically an illumination region 100 of the beam light in front of the vehicle. The reference symbol V denotes the central position of one headlamp and H

denotes the height of the horizontal plane of the headlamp. The cut lines of the illumination region 100 in the lateral direction of the vehicle are formed by the shade 40A shown in FIG. 2. The region shown by hatching above the cut line 102 is the region which is not illuminated with the beam light and the region below the cut line is the illumination region of the beam light.

[0022] When the shade 40A is rotated about the rotary shaft 44 with the motor 40D, the cut line 102 moves parallel to itself within a movement region from the first uppermost position H_1 (referred to hereinbelow as the first top dead center) shown by a solid line to the lowermost position L (referred to hereinbelow as the lower dead center) shown by a dash-dot line as a cut line 104. Further, the first top dead center H_1 of cut line is the uppermost position under usual conditions and the height thereof represents the position below the optical axis of the high beam. The second upper end point H_2 is the uppermost position in bad weather and the height thereof represents the position at the height of an almost horizontal plane of the headlamp. Further, the lower end point is a usual low beam position.

[0023] The configuration of the headlamp 18 was described above. Because the configuration of the right headlamp 20 is identical to that of headlamp 18, detailed explanation thereof will be omitted. The shade drive unit 41 is mounted on the headlamp 20, as shown in FIG. 4, and the cut line is moved by the shade drive unit 41.

[0024] As shown in FIG. 4, the control unit 50 comprises a read only memory (ROM) 52, a random access memory (RAM) 54, a central processing unit (CPU) 56, an input port 58, an output port 60, and a bus 62 such as a data bus or control bus connecting the above components. The ROM 52 stores the below-described control program for controlling shade drive units 40, 41. The RAM 54 temporarily stores a position signal for the vehicle recognized with the image processing unit 48. The CPU 56 sets the control signals for controlling the shade drive units 40, 41 according to the predetermined control program.

[0025] The wiper switch 68, fog lamp switch 70, and image processing unit 48 are connected to the input port 58. The image processing unit conducts processing of the image of the zone in front of the vehicle which is picked up with the TV camera 22 and specifies the position of the other vehicle based on the signals which are input from the TV camera 22 and control unit 50. The output port 60 is connected to the shade drive units 40, 41 via a driver 64. The output port 60 is also connected to the image processing unit 48. Furthermore, ON and OFF signals are supplied to the input port 58 from the wiper switch 58 and fog lamp switch 70, and a driver can detect changes in the meteorological conditions by turning those switches on and off.

[0026] The operation of the control unit changing the movement range of the cut line based on the signals from the TV camera, switches, and sensor will be described below with reference to FIG. 8 and FIG. 9. FIG. 8 is a flow chart of the main routine from the instant of recognizing the position of the vehicle to the instant the shade of the headlamp is moved. In Step 200, the other vehicle (oncoming vehicle or preceding vehicle) present in front of the vehicle is detected with the TV camera, image processing is conducted, and a position recognition treatment is conducted in which the position of the other vehicle is specified. In Step 202, a decision is made as to whether or not the conditions around the vehicle, in particular, meteorological conditions, have changed.

[0027] A subflow of Step 202 is explained below based on the flow chart shown in FIG. 9. In Step 300, the present position of the top dead center of the cut line is detected. In Step 302, a decision is made as to whether or not the rain has been falling around the vehicle and whether or not the wiper switch has been turned on. If the wiper switch has been turned on, the program proceeds to Step 310 and the movement range of the cut line is changed. If the wiper switch is turned off, in Step 304 a decision is made as to whereto there is a mist around the vehicle and whether or not the fog lamp switch has been turned on.. If the fog lamp switch has been turned on, the program proceeds to Step 310 and the movement range of the cut line is changed. If the fog lamp is turned off, a decision is made that the meteorological conditions around the vehicle are good, the top dead center is set to the first top dead center H_1 in Steps 306, 308, and the cut line is moved according to the position of the other vehicle within the cut line movement range shown in FIG. 6 (within the range from the first top dead center H_1 to the lower dead center L).

[0028] If in any one of Steps 302, 304 a decision is made that the switch has been turned on, then a decision is made that the meteorological conditions around the vehicle correspond to bad weather and control (from Step 310 to Step 314) is conducted to change the range to the bad weather movement range (range from the second top dead center H_2 to the lower dead center L) shown in FIG. 7. In Step 310, a decision is made as to whether the top dead center of the cut line is above the second top dead center H_2. If it is above, then in Step 312 the top dead center is changed to the second top dead center H_2. If it is in the second top dead center H_2, the cut line is moved according to the position of the other vehicle within the bad weather movement range.

[0029] In Step 204, a control signal of the motor of the shade drive unit is set based on the other vehicle position signal obtained in Step 200 and the height of the top dead center set in Step 202. In Step 206, the shade drive unit is driven and the cut line is moved.

[0030] If the above-described flow is thereafter repeated, when the conditions around the vehicle correspond to poor weather conditions, in particular, those of the rain, mist, and the like, the top dead center of the cut line movement range is changed to almost the height of the horizontal plane of the lamp and the beam light will not be projected above the height of the horizontal plane of the lamp. Therefore, the light curtain phenomenon can be reduced. Moreover, because the cut line is moved according to the position of the other vehicle within the movement range after changing, the driver can have the optimum front visibility.

[0031] In the above-described embodiment, a projector-type lamp was used as the headlamp. However, the present invention can be also applied to other headlamps. Moreover, a shade located inside the headlamp was used as means for moving the cut line. However, the present invention is also applicable to the headlamps in which the headlamp bulb or lamp house is moved.

[0032] Furthermore, the cylindrical shade was used as the shade, but this shape of the shade is not limiting. Thus, a plate-like shade, a shade divided into a plurality of sections, and the like can be used in other embodiments.

[0033] In the above-described embodiment, the ON-OFF switching of the wiper switch and fog

lamp switch was employed for detecting the changes in meteorological conditions. However, signals of rain sensors, fog sensors, illumination sensors, and the like may be also used.

[0034]

[Effect of the Invention] In the headlamp for a vehicle in accordance with the present invention, when the other vehicle is detected with a camera or the like and the position of the cut line of the headlamp is changed accordingly within the prescribed movement range, the state around the vehicle, in particular, the meteorological conditions such as the rain, mist, and the like, are detected, the top dead center of the cut line movement range is changed to almost a horizontal plane of the lamp and the beam light is not projected above the height of the horizontal plane of the lamp. Therefore, visibility in front of the vehicle can be improved, while reducing the light curtain phenomenon.

[Brief Description of the Drawings]

FIG. 1 is a perspective view illustrating the front part of the vehicle using the headlamp which is an embodiment of the present invention.

FIG. 2 is a perspective view illustrating a schematic structure of the headlamp in the embodiment of the present invention.

FIG. 3 is a cross sectional view along the III-III line in FIG. 2.

FIG. 4 is a block diagram illustrating the schematic structure of the control unit in the embodiment of the present invention.

FIG. 5 is a perspective vies of a shade of the headlamp in the embodiment of the present invention.

FIG. 6 is a schematic view illustrating the cut line movement range in a normal state in the beam light illumination range in the embodiment of the present invention.

FIG. 7 is a schematic view illustrating the cut line movement range during poor weather in the beam light illumination range in the embodiment of the present invention.

FIG. 8 is a flow chart illustrating the main routine of the control in the embodiment of the present invention.

FIG. 9 is a flow chart illustrating changes of the cut line movement range in the embodiment of the present invention.

[Legends]

18, 20 HEADLAMP
22 TV CAMERA (VEHICLE POSITION DETECTION MEANS)
40, 41 SHADE DRIVE UNIT (POSITION CHANGING MEANS)
48 IMAGE PROCESSING UNIT (VEHICLE POSITION DETECTION MEANS
50 CONTROL UNIT (POSITION CHANGING MEANS)
68 WIPER SWITCH (STATE DETECTION MEANS)
70 FOG LAMP SWITCH (STATE DETECTION MEANS)

FIG. 4

18 HEADLAMP
20 HEADLAMP
22 TV CAMERA (VEHICLE POSITION DETECTION MEANS)
40 SHADE DRIVE UNIT (POSITION CHANGING MEANS)
41 SHADE DRIVE UNIT (POSITION CHANGING MEANS)
BATTERY
48 IMAGE PROCESSING UNIT (VEHICLE POSITION DETECTION MEANS
50 CONTROL UNIT (POSITION CHANGING MEANS)
58 INPUT PORT
60 OUTPUT PORT
64 DRIVER
68 WIPER SWITCH (STATE DETECTION MEANS)
70 FOG LAMP SWITCH (STATE DETECTION MEANS)

FIG. 6

NON-ILLUMINATED REGION
ILLUMINATED REGION

FIG. 7

NON-ILLUMINATED REGION
ILLUMINATED REGION

FIG. 8

200 POSITION RECOGNITION OF ANOTHER VEHICLE
202 SETTING THE CUT LINE (SHADE) MOVEMENT POSITION
204 SETTING THE CONTROL SIGNAL OF SHADE DRIVE UNIT
206 CUT LINE (SHADE) MOVEMENT

FIG. 9

300 DETECTION OF THE PRESENT TOP DEAD CENTER OF CUT LINE (SHADE) : X
302 WIPER SWITCH ON
304 FOG LAMP ON
308 TOP DEAD CENTER H_1 IN THE MOVEMENT RANGE IN THE NORMAL STATE
314 TOP DEAD CENTER H_2 IN THE MOVEMENT RANGE DURING POOR WEATHER

Continued from the front page
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【図1】本発明の実施例に利用した車両の前部を示す斜視図。

【図2】本発明の実施例におけるヘッドランプの概略構成を示す斜視図。

【図3】図2におけるIII－III線の断面図。

【図4】本発明の実施例における制御装置の概略構成を示すブロック図。

【図5】本発明の実施例におけるヘッドランプのシェードの斜視図。

【図6】本発明の実施例のビーム光の照射領域における通常時のカットラインの移動範囲を示す概略図。

【図7】本発明の実施例のビーム光の照射領域における悪天候時のカットラインの移動範囲を示す概略図。

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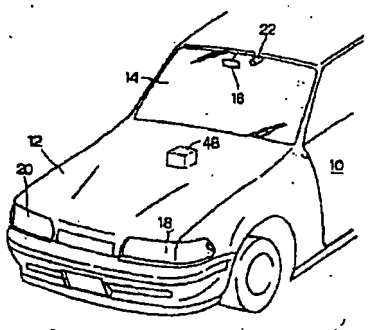
【図8】本発明の実施例における制御メインルーチンを説明するフローチャート。

【図9】本発明の実施例におけるカットラインの移動範囲の変更を説明するフローチャート。

【符号の説明】

18、20	・・・	ヘッドランプ
22	・・・	TVカメラ（車両位置検出手段）
40、41	・・・	シェード駆動部（位置変更手段）
48	・・・	画像処理装置（車両位置検出手段）
50	・・・	制御装置（位置変更手段）
68	・・・	ワイパスイッチ（状態検出手段）
70	・・・	フォグランプスイッチ（状態検出手段）

【図1】



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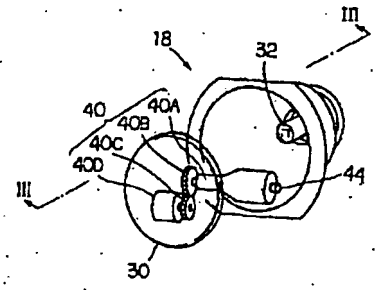

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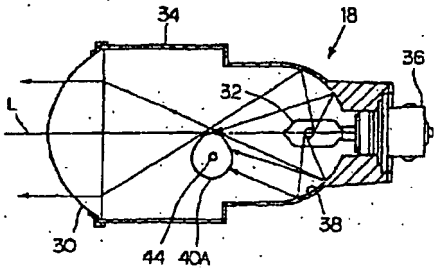

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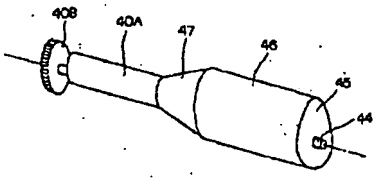

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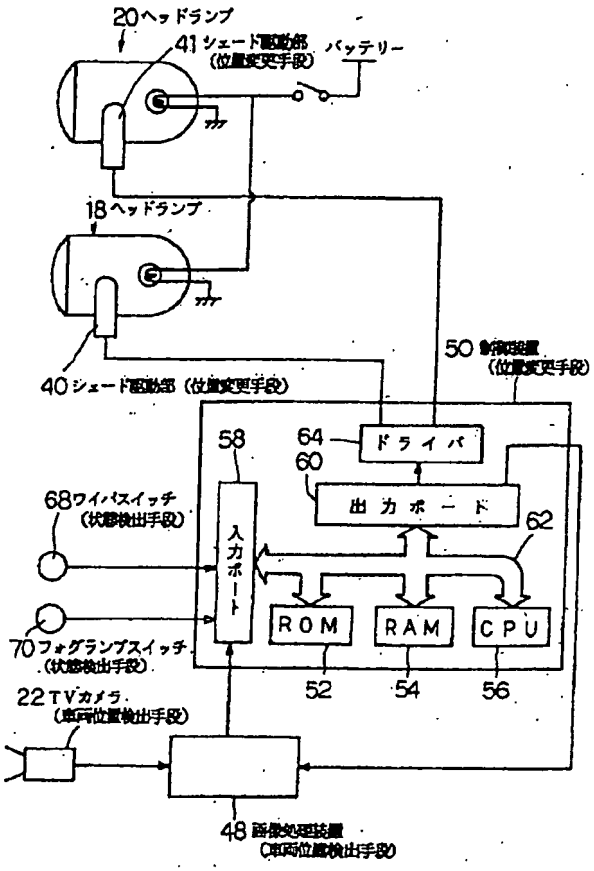
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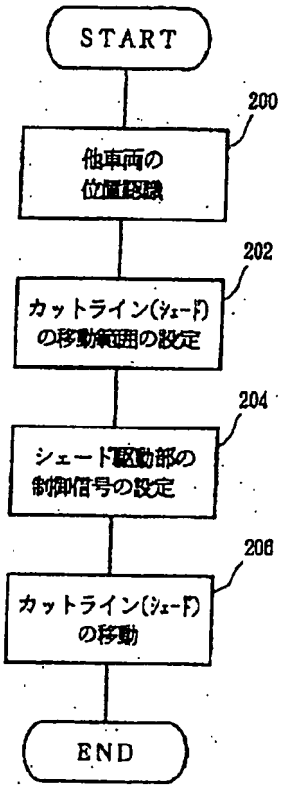
41シェード駆動部
(位置変更手段)
バッテリー
18ヘッドランプ
40シェード駆動部 (位置変更手段)
50 制御装置
(位置変更手段)
58
64
ドライバ
60
出力ポート
68ワイパスイッチ
(状態検出手段)
入力ポート
62
ROM
RAM
CPU
70フォグランプスイッチ
(状態検出手段)
52
54
56
22TVカメラ
(車両位置検出手段)
48 画像処理装置
(車両位置検出手段)

【図8】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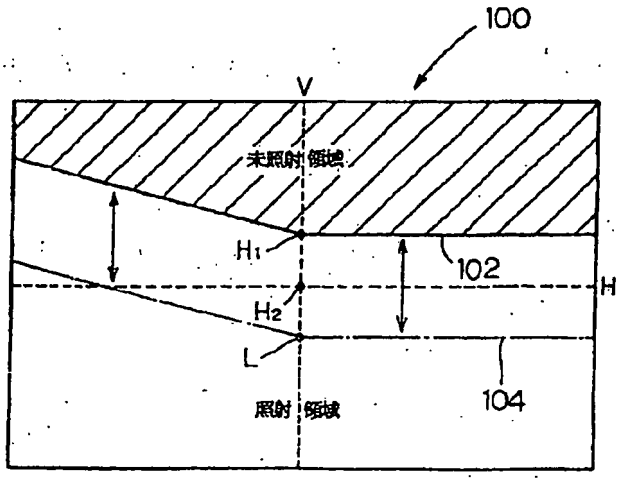
200
他車両の
位置認識
202
カットライン(シェード)
の移動範囲の設定
204
シェード駆動部の
制御信号の設定
206
カットライン(シェード)
の移動
END

【図6】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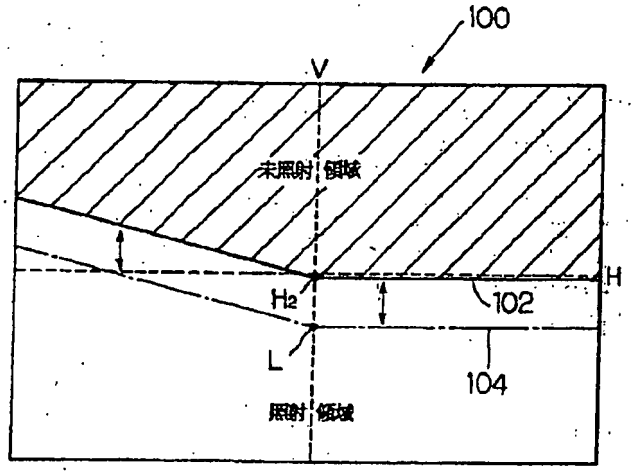
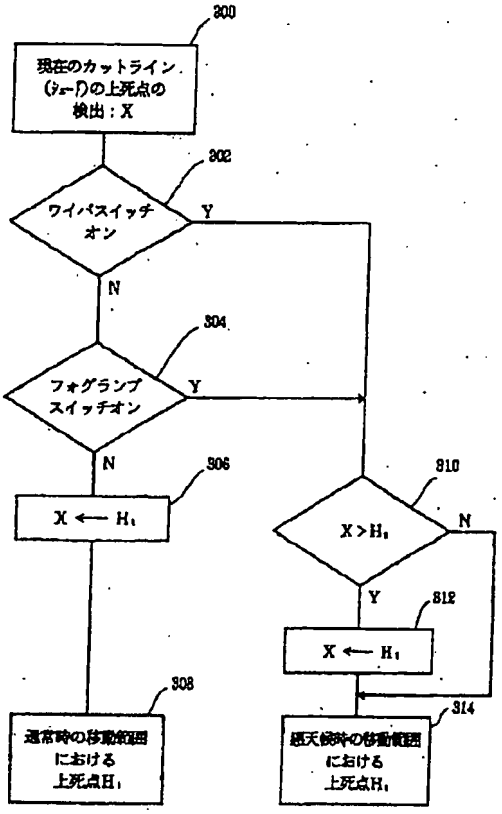
【図7】



【図9】



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(19) Japan Patent Office (JP)
(12) Publication of Patent Application
(11) Publication Number of Patent Application: 7-47878
(43) Date of Publication of Application: February 21, 1995

(51) Int.Cl.[6]	Identification Number	Intraoffice Reference Number	F1	Field of Technology Indication
B60Q 1/08		8715-3K		
1/14		F8715-3K		
F21M 3/05		B8409-3K		
3/18		8409-3K		
H04N 7/18		K		

Request for Examination: not made
Number of claims: 2 OL (8 pages in total)

(21) Application Number: 5-194464
(22) Application Date: August 5, 1993

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(54) [Title of the Invention] HEADLAMP FOR VEHICLE

(57) [Abstract]

[Object] To reduce the light curtain phenomenon during bad weather.

[Structure] The position of another vehicle present in front of the vehicle is recognized with a TV camera 22 and an image processing unit 48 and the cut lines of the headlamps 18, 20 are moved within the prescribed movement range by the shade drive units 40, 41 correspondingly to the position of the other vehicle. Furthermore, if the headlamps are ON, the vehicle travels in bad weather (rain, fog, etc.), and the signal indicating that the

wiper switch 68 or fog lamp switch 70 is ON is inputted to a control unit 50, the top dead center, which is the uppermost-level position in the movement range of the cut line, is changed to a position where no light curtain phenomenon is generated and the cut line is moved in the movement range, which has been changed, correspondingly to the position of the other vehicle.

[Patent Claims]

[Claim 1] A headlamp for a vehicle comprising vehicle position detection means for detecting the position of another vehicle, position changing means for changing the position of a cut line, which is a boundary between an illumination region and a non-illumination region of the headlamp, within a prescribed movement range, state detection means for detecting the state around the vehicle, and control means for controlling said position changing means based on the signal of said vehicle position detection means, characterized in that said position changing means changes the top dead center, which is the uppermost-level position of the cut line in the movement range, correspondingly to the signals of said state detection means.

[Claim 2] The headlamp for a vehicle according to claim 1, characterized in that said position changing means changes the top dead center of said cut line to about the height of a horizontal plane of the lamp if said state detection means detects meteorological conditions such as rain and fog that cause the light curtain phenomenon of the headlamp.

[Detailed Description of the Invention]

[0001]

[Field of Industrial use] The present invention relates to a headlamp for a vehicle, and more particularly to a headlamp for a vehicle that inhibits a light curtain phenomenon occurring in front of the vehicle when the vehicle travels in bad weather.

[0002]

[Prior Art] Headlamps are installed on the left and right side of the front end section of a vehicle and turned on when the road in front of the vehicle is difficult to view, e.g., at night, to improve forward visibility for the driver. Generally, the headlamps have a structure allowing the illumination range of the beam light to be switched between two levels: a high beam level mainly for far-range illumination and a low beam level for close-range illumination. When another vehicle such as a vehicle ahead or an oncoming vehicle is present, a low beam level is most often selected so as to avoid unnecessary glare dazzling the driver of the other vehicle.

[0003] In a low-beam state of the headlamp, part of the beam light (far-range illumination beam light) is shielded. For example, in a projection-type headlamp, a shading plate (referred to hereinbelow as "shade") for shielding part of the beam light is

provided inside the headlamp, a boundary (this boundary is referred to hereinbelow as "cut line") between the illumination region and non-illumination region of the beam light in front of the vehicle is formed by the shade, and the beam light emitted by the light source is divided into the illumination light and non-illumination light.

[0004] However, the problem is that, for example, in the case of a large distance to the vehicle ahead, in a low beam mode, the driver continuously views the dark section, which is the non-illumination region of the headlamp, whereas in a high beam mode, the adequate range in front of the vehicle is difficult to illuminate because of a danger of causing glare to the drivers of vehicles ahead.

[0005] In order to resolve this problem, a variety of methods have been suggested to ensure visibility (illumination range of maximum possible distance) above the visibility (close-range illumination) obtained with the low beam according to the state of environment around the vehicle. For example, Japanese Patent Application Laid-open No. H1-278848 suggested a "Headlamp Device for Vehicle". This device comprises a headlamp equipped with a shade, the position of another vehicle is detected with a detection sensor disposed close to the headlamp, the headlamp is moved in the vertical direction correspondingly to the detection signal, the position of the cut line is changed, and visibility is improved by illuminating a maximum possible range, while preventing the driver of the other vehicle from being dazzled.

[0006] Furthermore, Japanese Patent Application Laid-open No. S63-129641 disclosed a headlamp light quantity control unit for a vehicle as technology for improving visibility in front of the vehicle. This unit comprises a vehicle sensor such as a rain sensor for detecting rain or a light sensor for detecting the presence of an oncoming vehicle, voltage is controlled with a liquid quantity setting device corresponding to the signal of each sensor, and the quantity of light of the head lamp is increased or decreased.

[0007] With this configuration, when the rain is falling, the rain sensor detects the rain, the signal thereof is sent to the light quantity setting unit, and the light quantity setting unit changes the control voltage so as to increase the light quantity of the headlamps by comparison with that of the clear weather. As a result, visibility in front of the vehicle is improved.

[0008]

[Problems Addressed by the Invention] However, when a vehicle travels at night in a bad weather (for example, in rain or fog), the beam light of the headlamp is reflected and scattered to a degree higher than that during usual driving, the road surface is not sufficiently illuminated, and visibility in front of the vehicle is sometimes degraded. For example, if a headlamp operates in a high beam mode under the rain, the beam light emitted above the horizontal plane of the lamp is reflected and scattered, thereby inducing a light curtain phenomenon, that is, a white wall appears to be present in front of the vehicle.

[0009] Within the framework of the conventional technology (Japanese Patent Application Laid-open No H1-278848), in the case of a headlamp in which a cut line is moved according to the position of another vehicle, if the cut line is raised above the horizontal plane of the lamp to illuminate a maximum possible range, without taking a bad weather into consideration, then the light curtain phenomenon is induced in front of the vehicle and the visibility conversely decreases. Furthermore, as suggested by the other conventional method (Japanese Patent Application laid-open No S63-129641), if the quantity of light above the horizontal plane of the lamp is increased during the rain, without forming a cut line in the headlamp, the light curtain phenomenon might similarly occur.

[0010] Accordingly, it is an object of the present invention to change the top dead center of the movement range of the cut line in a bad weather and inhibit the quantity of light above approximately the horizontal line of the lamp, thereby reducing the light curtain phenomenon and improving visibility in front of the vehicle.

[0011]

[Means to Resolve the Problems] In order to resolve the above-described problems, the present invention provides a headlamp for a vehicle comprising vehicle position detection means for detecting the position of another vehicle, position changing means for changing the position of a cut line, which is a boundary between an illumination region and a non-illumination region of the headlamp, within a prescribed movement range, state detection means for detecting the state around the vehicle, and control means for controlling the position changing means based on the signal of the vehicle position detection means, characterized in that the position changing means changes the top dead center, which is the uppermost-level position of the cut line in the movement range, correspondingly to the signals of the state detection means.

[0012] Furthermore, the position changing means is characterized in that it changes the top dead center of the cut line about to the height of a horizontal plane of the lamp if the state detection means detects meteorological conditions such as rain and fog that cause the light curtain phenomenon of the headlamp.

[0013]

[Operation] With the headlamp for a vehicle in accordance with the present invention, the position of another vehicle in front of the vehicle is recognized with the vehicle position detection means. Then, the control means changes the position of the cut line with the position changing means based on the position signal of the other vehicle. At this time, if the state detection means detects the state around the vehicle, more particularly detects meteorological conditions such as rain and fog that cause the light curtain phenomenon of the headlamp, the control means changes the top dead center of the movement range of the cut line about to the height of a horizontal plane of the lamp and moves the cut line correspondingly to the position of the other vehicle inside the

changed movement range.

[0014]

[Embodiments] An embodiment of the present invention will be described hereinbelow with reference to FIG. 1 to FIG. 4. In the present embodiment, projector-type headlamps are used as the headlamps.

[0015] As shown in FIG. 4, the headlamp for a vehicle of the present embodiment comprises a TV camera 22 and an image processing unit 48 serving as vehicle position detection means, a wiper switch 68 and a fog lamp switch 70 serving as state detection means, headlamps 18, 20, shade drive units 40, 41 comprising a shade forming a cut line as position changing means, and a control unit 50 serving as control means.

[0016] As shown in FIG. 1, a pair of headlamps 18, 20 are installed at both ends in the front section in the lateral direction of the vehicle in a front body 12 of a vehicle 10. Furthermore, a room mirror 16 is provided in the vicinity of the upper section of a windshield glass 14 inside the vehicle 10. The TV camera 22 for picking up the images in front of the vehicle is disposed in the vicinity of the room mirror 16. The TV camera 22 is connected to the image processing unit 48.

[0017] The headlamps will be described below. Because the left and right headlamps have identical configurations, only the left headlamp 18 will be explained. The headlamp 18 is a projector-type headlamp and comprises, as shown in FIG. 2 and FIG. 3, a convex lens 30, a bulb 32, a lamp housing 34, and a shade drive unit 40 comprising a shade 40A for controlling a cut line. The lamp housing 34 is fixed almost horizontally to a frame (not shown in the figure) of the vehicle. The convex lens 30 is fixed in one opening of the lamp housing 34, and the bulb 32 is fixed in the other opening via a socket 36 so that the light emission point is positioned on an optical axis L (central axis of the convex lens 30) of the convex lens 30.

[0018] A reflector 38 with an elliptical reflecting surface is formed on the bulb 32 side inside the lamp housing 34. The beam light emitted from the bulb 32 is reflected by the reflector 38 and converged in a convergence point on the optical axis L between the convex lens 30 and the bulb 32. The shade drive unit 40 is disposed in the vicinity of the convergence point.

[0019] The shade drive unit 40 comprises the shade 40A rotatably supported on a rotation shaft 44 fixed so as to extend in the lateral direction of the vehicle inside the lamp housing 34. A gear 40B is fixedly mounted on the shade 40A. A gear 40C fixedly mounted on a drive shaft of a motor 40D is engaged with the gear 40B. The motor 40D is connected to a drive unit 64 of a control unit 50 shown in FIG. 4. Furthermore, as shown in FIG. 5, the shade 40A has an almost cylindrical structure having a cam-shaped cross section 45 such that the distance from the rotation shaft 44 to the outer periphery changes continuously along the circumferential direction. The other surface thereof changes

continuously along the lateral direction of the vehicle. A cut line of the headlamp is formed by a horizontal section 46 and an inclined section 47 formed on the side surface of the shade 40A.

[0020] A beam light of the bulb 32 reflected and converged by the reflector 38 is partly shielded by the shade 40A and the other part of the beam light is projected from the convex lens 30. The shade is rotated by driving the motor 40D according to a signal from the control unit 50. Following this rotation of the shade 40A, the position of the cut line of the beam line changes in the vertical direction.

[0021] FIG. 6 and FIG. 7 are schematic drawings illustrating an illumination region of a beam light in front of the vehicle. The symbol V in the figures shows a central position of one headlamp, and the symbol H shows the height of the horizontal surface of the headlamp. Cut lines 102, 104 in the lateral direction of the vehicle in the illumination region 100 are formed by the shade 40A shown in FIG. 2. The region shown by hatching above the cut line 102 is a region that is not illuminated with the beam light, and the region below this line is the illumination region of the beam light.

[0022] When the shade 40A is rotated by the rotation shaft 44 driven by the motor 40D, the cut line 102 moves parallel to itself through a movement region from the first uppermost position H_1 shown by a solid line (referred to hereinbelow as a first top dead center) to the lowermost position L (referred to hereinbelow as a lower dead center) shown by a dot-dash line and serving as the cut line 104. The first top dead center H_1 of the cut line is the uppermost position in a normal state, and the height thereof is below the optical axis of a high beam. A second top dead center H_2 is the uppermost position during bad weather and the height thereof is almost that of a horizontal surface of the headlamp. Furthermore, the lower dead center L corresponds to the usual position of a low beam.

[0023] The configuration of the headlamp 18 was described above. Because, the right headlamp 20 has the same configuration as the headlamp 18, detailed explanation thereof is omitted. In the headlamp 20, the shade drive unit 41 is attached as shown in FIG. 4, and the cut line moves when driven by the shade drive unit 41.

[0024] As shown in FIG. 4, the control unit 50 comprises a read only memory (ROM) 52, a random access memory (RAM) 54, a central processing unit (CPU) 56, an input port 58, and output port 60, and a bus 62 such as a data bus or a control bus that connects the aforementioned components. A control program for controlling the below-described shade control units 40, 41 is stored in the ROM 52. The RAM 54 temporarily stores a position signal of another vehicle recognized by the image processing unit 48. The CPU 56 sets control signals for controlling the shade drive units 40, 41 by a preset control program.

[0025] The wiper switch 68, fog lamp switch 70, and image processing unit 48 are connected to the input port 58. The image processing unit 48 conducts image processing

of images in front of the vehicle that were picked up by the TV camera based on the signals inputted from the TV camera 22 and control unit 50 and specifies the position of the other vehicle. The shade drive units 40, 41 are connected to the output port 60 via the drive unit 64. Furthermore, the image processing unit 48 is also connected to the output port 60. ON/OFF signals are sent from the wiper switch 68 and fog lamp switch 70 to the input port 58, and a driver can detect changes of meteorological conditions by switching each switch ON and OFF.

[0026] The operation in which the control unit changes the movement range of the cut line based on the signals from the TV camera, switches, and sensors will be described below with reference to FIG. 8 and FIG. 9. FIG. 8 is a flowchart of a main routine from the aforementioned position recognition of the other vehicle with the TV camera to a step of moving the shade of the headlamp. In step 200, other vehicles (oncoming vehicle and vehicle ahead) present in front of the vehicle are detected with the TV camera, image processing is conducted, and image recognition processing that specifies the position of other vehicles is executed. In step 202, a decision is made as to whether or not the state around the vehicle, more particularly meteorological conditions have changed.

[0027] The sub-flow of step 202 will be explained with a flowchart shown in FIG. 9. In step 300, the present position of the top dead center of the cut line is detected. In step 302, whether it is raining around the vehicle is determined based on whether or not the wiper switch is turned on. If it is turned on, the routine advances to step 310 and the movement range of the cut line is changed. If the switch is off, whether it is foggy around the vehicle is determined based on whether or not the fog lamp witch is turned on. If it is turned on, the routine advances to step 310 and the movement range of the cut line is changed. If the switch is off, the meteorological conditions are determined to be good, the top dead center is set to the first top dead center H_1 in steps 306, 308, and the cut line is moved correspondingly to the positions of other vehicles in the cut line movement range (range from the first top dead center H_1 to the lower dead center L) shown in FIG. 6.

[0028] If a switch is determined to be ON in any one of the steps 302, 304, the meteorological conditions around the vehicle are determined to be poor, and control (step 310 to step 314) is conducted to change the mode to a bad weather movement range (range from the second top dead center H_2 to the lower dead center L) shown in FIG. 7. In step 310, whether the top dead center of the cut line is above the second top dead center H_2 is determined. If it is above the second top dead center, the top dead center is changed to the second top dead center H_2 in step 312. If the top dead center is positioned in the second top dead center H_2, the cut line is moved correspondingly to the positions of other vehicles in the bad weather movement range in step 314.

[0029] In step 204, a control signal of the motor of the shade drive unit is set based on the position signal of the other vehicle obtained in step 200 and the height of the top dead center that was set in step 202. Then, in step 206, the shade drive unit is driven and the cut line is moved.

[0030] In the case of poor conditions around the vehicle, in particular when the weather is bad (rain, fog, etc.), the top dead center of the movement range of the cut line is changed almost to the height of a horizontal plane of the lamp by repeating the above-described operations and the beam light is not projected above the height of the horizontal plane of the lamp. Therefore, the light curtain phenomenon can be reduced. Moreover, because the cut line is moved correspondingly to the positions of other vehicles within the changed movement range, an optimum forward visibility can be attained for the driver.

[0031] In the above-described embodiment, a projection-type headlamp was used as the vehicle headlamp, but the present invention can be also employed with other headlamps. Furthermore, a shade located inside the headlamp was used as a method for moving the cut line, but the present invention can be also employed with respect to headlamps in which a headlamp bulb of lamp housing is moved.

[0032] Furthermore, a cylindrical shade was used, but this shape of the shade is not limiting. In other embodiments, the present invention can be employed with a plate-like shape or a shade divided into a plurality of sections.

[0033] In the above-described embodiment, changes in meteorological conditions were detected by determining the ON/OFF state of the wiper switch and fog lamp switch, but signals from a rain sensor, fog sensor, or illumination sensor may be used in other embodiments.

[0034]

[Effect of the Invention] With the headlamp for a vehicle in accordance with the present invention, when other vehicles are detected, e.g., with a camera, and the position of the cut line of the headlamp is changed within a prescribed movement range, conditions around the vehicle, more particularly meteorological conditions (rain, fog, etc.) are detected, the top dead center of the movement range of the cut line is moved almost to a horizontal plane of the lamp, and the illumination with beam light above the height of the almost horizontal plane of the lamp is prevented. As a result, visibility in front of the vehicle can be improved, while reducing the light curtain phenomenon.

[Brief Description of the Drawings]

FIG. 1 is a perspective view illustrating the front section of the vehicle used in the embodiment of the present invention.

FIG. 2 is a perspective view illustrating a schematic structure of the headlamp in the embodiment of the present invention.

FIG. 3 is a cross-sectional view along the III-III line in FIG. 2.

FIG. 4 is a block-diagram illustrating a schematic configuration of the control unit in the embodiment of the present invention.

FIG. 5 is a perspective view of a shade of the headlamp in the embodiment of the

present invention.

FIG. 6 is a schematic drawing illustrating the movement range of the cut line under normal conditions in the illumination region of the beam light in the embodiment of the present invention.

FIG. 7 is a schematic drawing illustrating the movement range of the cut line under bad weather conditions in the illumination region of the beam light in the embodiment of the present invention.

FIG. 8 a flowchart illustrating the control main routine in the embodiment of the present invention.

FIG. 9 is a flowchart illustrating changes in the movement range of the cut line in the embodiment of the present invention.

[Keys]

18, 20 headlamp
22 TV camera (vehicle position detection means)
40, 41 shade drive unit (position changing means)
48 image processing unit (vehicle position detection means)
50 control unit (position changing means)
68 wiper switch (state detection means)
70 fog lamp switch (state detection means)

FIG. 4

18 HEADLAMP
20 HEADLAMP
22 TV CAMERA (VEHICLE POSITION DETECTION MEANS)
40 SHADE DRIVE UNIT (POSITION CHANGING MEANS)
BATTERY
41 SHADE DRIVE UNIT (POSITION CHANGING MEANS)
BATTERY
48 IMAGE PROCESSING UNIT (VEHICLE POSITION DETECTION MEANS)
50 CONTROL UNIT (POSITION CHANGING MEANS)
58 INPUT PORT
60 OUTPUT PORT
64 DRIVER
68 WIPER SWITCH (STATE DETECTION MEANS)
70 FOG LAMP SWITCH (STATE DETECTION MEANS)

FIG. 6

NON-ILLUMINATION REGION
ILLUMINATION REGION

FIG. 7

NON-ILLUMINATION REGION
ILLUMINATION REGION

FIG. 8

200 POSITION OF ANOTHER VEHICLE IS RECOGNIZED
202 MOVEMENT RANGE OF CUT LINE (SHADE) IS SET
204 CONTROL SIGNAL OF SHADE DRIVE UNIT IS SET
206 CUT LINE (SHADE) IS MOVED

FIG. 9

300 TOP DEAD CENTER OF PRESENT CUT LINE (SHADE) IS DETECTED: X
302 IS WIPER SWITCH ON?
304 IS FOG LAMP SWITCH ON?
308 TOP DEAD CENTER H_1 IN MOVEMENT RANGE UNDER NORMAL CONDITIONS
314 TOP DEAD CENTER H_2 IN THE MOVEMENT RANGE IN BAD WEATHER

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VERIFICATION OF A TRANSLATION

I, the below named translator, hereby declare that:

My name and post office address are as stated below:
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That I am knowledgeable in the English language and in the language in which the below identified international document was written, and that I believe the English translation of the attached document

Headlamp Device for Vehicle

JP-A-7-47878

is a true and complete translation of the above identified document.

I hereby declare that all statements made herein are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the document.

October 14, 2005
Date

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